University of Technology, Sydney

Faculty of Engineering

High Rate Physico-Chemical Process as a Pre-treatment to Membranes Used in Water Reuse

by

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A thesis submitted to fulfilment
of the requirements for the degree of
Master of Engineering

University of Technology, Sydney
Faculty of Engineering

July, 2011

CERTIFICATE OF AUTHORSHIP

I certify that the work in this thesis has not previously been submitted for any degree nor has it been submitted as part of requirements for a degree except as fully acknowledge within the text.

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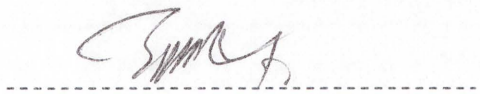

(Rana Tanveer Ahmad)

ACKNOWLEDGEMENT

I would like to express my deepest gratitude and appreciation to my principle supervisor, Professor S. Vigneswaran for his valuable suggestion, guidance, comments and continuous support at all levels during my study at UTS. I also wish to express my profound gratitude and appreciation to my co-supervisor, Dr Kandasamy for proofreading the thesis and for his assistance in mathematic modeling.

I extend my gratitude to Professor Vigneswaran, who guided me continuously from start to end of my study. I would like to thank him for his financial support during my study. I would like to also thank Dr Hao for his support while working in the Environmental lab.

In addition, I would like to thank Dr. Tien Vinh Nguyen, who offered generous assistance on the start-up as well as the progress of the study. Also, I wish to thank him for his assistance in installing the fluidized column and submerged membrane reactor. I like to thank Chinu Khorshed for sharing her experience in monitoring the submerged membrane reactor and analysing MWD and LC-OCD results. I would like to thank Javid, Thanh and Johir for their generous help in the experimental phase of this research, and staff in the Research Office for their friendship and companionship.

The research in this thesis has been funded by the Australian Research Council (ARC) Discovery
Grant. I greatly acknowledge the financial support for the final semester of my Masters degree by Faculty of Engineering, University of Technology, Sydney (UTS).

Finally, I wish to thank my wife and children Hassan, Munahil and Areebah who provided me happiness, and made this work possible. I will be indebted throughout my life to my parents for their sacrifices in raising me to the present level.

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Nomenclature

A	=	the specific surface area of the media
b	=	Langmuir constant
C	=	bulk organic concentration (mg/L)
C_0	=	initial concentration of bulk solution (mg/L)
C_e	=	the equilibrium organic concentration (mg/L)
D	=	inside diameter of fluidized column (m)
H	=	column bed height (m)
K_F	=	Freundlich isotherm capacity constant
k_H	=	adsorption coefficient
1/n	=	Freundlich isotherm intensity constant
q	=	measured amount organic adsorbed
q_m	=	adsorption capacity (mg/g)
Q	=	flow rate (m^3/h)
r^2	=	coefficient of correlation
t	=	detention time (h)
T	=	absolute temperature (K)
TMP	=	transmembrane pressure (KPa)
v	=	fluidization velocity (m/h)
V	=	volume of the solution in batch reactor (mL)

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ABSTRACT

The presence of NOM in the source water adversely affects drinking water treatments and water quality. NOM is thus known to increase disinfectant and coagulant demand, fouls membrane and favours biological regrowth in the distribution network. Extensive work has focused on enhanced coagulation, activated carbon adsorption and membrane processes as strategies to remove dissolved organic carbon.

The main objective of this study is to assess the impact of Purolite®A500PS ion exchange resin on dissolved organic carbon (DOC) removal and fouling reduction of membrane filtration used as post-treatment. Moreover, the effect of Purolite®A500PS on hydrophilic and hydrophobic substances removal from biologically treated sewage effluent (BTSE) was also studied.

Purolite®A500PS can effectively remove effluent organic matter (EfOM) from biologically treated sewage effluent. At a dose of 0.5g/L, Purolite®A500PS was able to remove as high as 84% of DOC from synthetic wastewater and 79% from real biologically treated sewage effluent. It was found that DOC removal efficiency strongly depended on the size of Purolite®A500PS. An investigation of the adsorption equilibrium behaviour of Purolite®A500PS ion exchange indicated that the Langmuir and Freundlich models fitted well with the experimental data. In addition, kinetic adsorption of Purolite®A500PS with organic compound can be described by the Ho model. A series of batch experiments were conducted to evaluate the effect of different influent concentration on the performance of Purolite®A500PS. The results indicated that the DOC adsorption rate of Purolite®A500PS dropped 76% to 45% when initial concentration increased from 10 mg/L to 20 mg/L.

Fluidised bed Purolite®A500PS column can effectively remove 74.5% of DOC from wastewater effluent. The smaller size of 150~300 μm of Purolite®A500PS is more effective in DOC removal because of its higher detention time and longer bed depth.

Purolite®A500PS fluidized bed treatment was significantly affected by bed depth and fluidization velocity. Higher bed depths and lower fluidization velocity led to a superior DOC removal from synthetic wastewater. An increase of 20% in the removal of efficiency was attained when GAC was used in the first step prior to Purolite®A500PS fluidized treatment. Moreover, adsorption of large MW compounds was significant when both GAC and Purolite®A500PS were used as a filter medium. Combination of GAC and Purolite®A500PS treatment removed larger molecular size fraction (more than 600 Da) more effectively whereas smaller molecular size fraction (below 300 Da) could also be removed to some extent. In addition, LC-OCD analysis demonstrated that pre-treatment of GAC on Purolite®A500PS decreased more than 95% of hydrophobic and hydrophilic from synthetic wastewater.

Post-treatment by flocculation was considered to improve further DOC. It was found that the optimum flocculant dose reduced significantly from 40 mg/L to 18 mg/L when SWW was pre-treated by Purolite®A500PS fluidized column. The combined treatment led to a higher DOC removal efficiency of 84%.

When the Purolite®A500PS fluidized column effluent was pumped into the submerged membrane reactor, an increase of 10% in organic removal was achieved after filtration. The critical flux of submerged membrane hybrid reactor system was increased from 20 $L/m^2.h$ to 35 $L/m^2.h$ when a dose of 0.1 g/L particle size of 150-300 μm of Purolite®A500PS was added. The TMP was decreased from 30KPa with conventional submerged membrane system to 13KPa with submerged membrane hybrid reactor system.